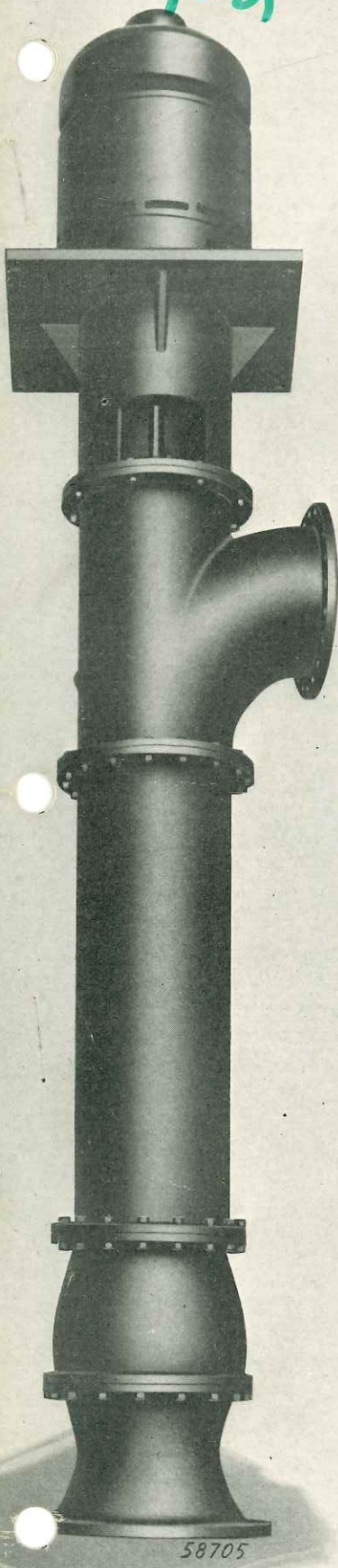


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Instructions for Installing and Operating Vertical Pumps

Class **APM** and **APS**



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Ingersoll-Rand

Cameron Pump Division
11 BROADWAY, NEW YORK CITY

Instructions for Installing and Operating Vertical Pumps Class APM and APS

This instruction book has been prepared to assist users of Ingersoll-Rand type APM and APS pumps in their installation, operation and maintenance. Class APM pumps are mixed-flow type, Figure 1; and class APS are axial-flow propeller type, Figure 5. As individual units differ as to length of column, type of bearing lubrication, driver, etc, it must be understood that the sectional assembly drawings included in this book are representative only, and that the specific sectional assembly and elevation drawings furnished with the unit should be consulted for accurate details. The company will gladly advance any specific information not included in the following pages. Address the nearest I-R branch office as listed on the last page of this book.

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A. GENERAL

1. Description of pumps

These pumps are designed for vertical installation and consist of a pumping element suspended in a vertical column. There is an outer column through which the liquid flows upward from the impeller, and an inner column which contains intermediate bearings and protects the shaft from the liquid being pumped.

The pumping element is assembled as a self-contained unit, consisting of the suction bell, impeller, pump casing and the lower section of shaft.

The outer column sections are connected by flanges having rabbeted fits to assure alignment in assembly. The inner column is divided into suitable lengths which are coupled by means of the intermediate bearing bushings, the outer diameters of which are threaded for that purpose. The shaft sections are joined with threaded couplings, the threads being such that the driver torque tightens the joint. NOTE: While reverse flow at shut down may cause reverse rotation of the unit, this torque is applied at the lower end of the pump and hence also tightens the shaft couplings.

The outer column is supported from the supporting-head plate which is mounted on beams or a suitable ring at the floor level. Above the plate is mounted a driver support ring and flange to which the driver is bolted.

The impeller has a downward thrust which is proportional to the pumping head under operation. This thrust places the driving shaft under tension and is carried by a special thrust bearing in the driver.

2. Drivers

Vertical pumps may be driven by an electric motor, right-angle gear or pulley head. The driver shaft can be either solid or hollow type. Any type of driver which is used must be suitable for carrying the total thrust load of the pump.

With a solid-shaft driver a rigid adjustable coupling is used between driver and pump, and vertical adjustment (described in detail later) is made in the coupling. With a hollow-shaft driver, a rigid coupling may be used between the pump and motor shaft, or the hollow shaft may fit directly over an extension of the pump shaft. With all hollow-shaft drivers, the vertical adjustment of the pumping element is made at the top of the driver.

3. Materials

Materials of construction are selected according to the service for which the unit is to be used. The outer column and discharge elbow may be either of cast or fabricated construction.

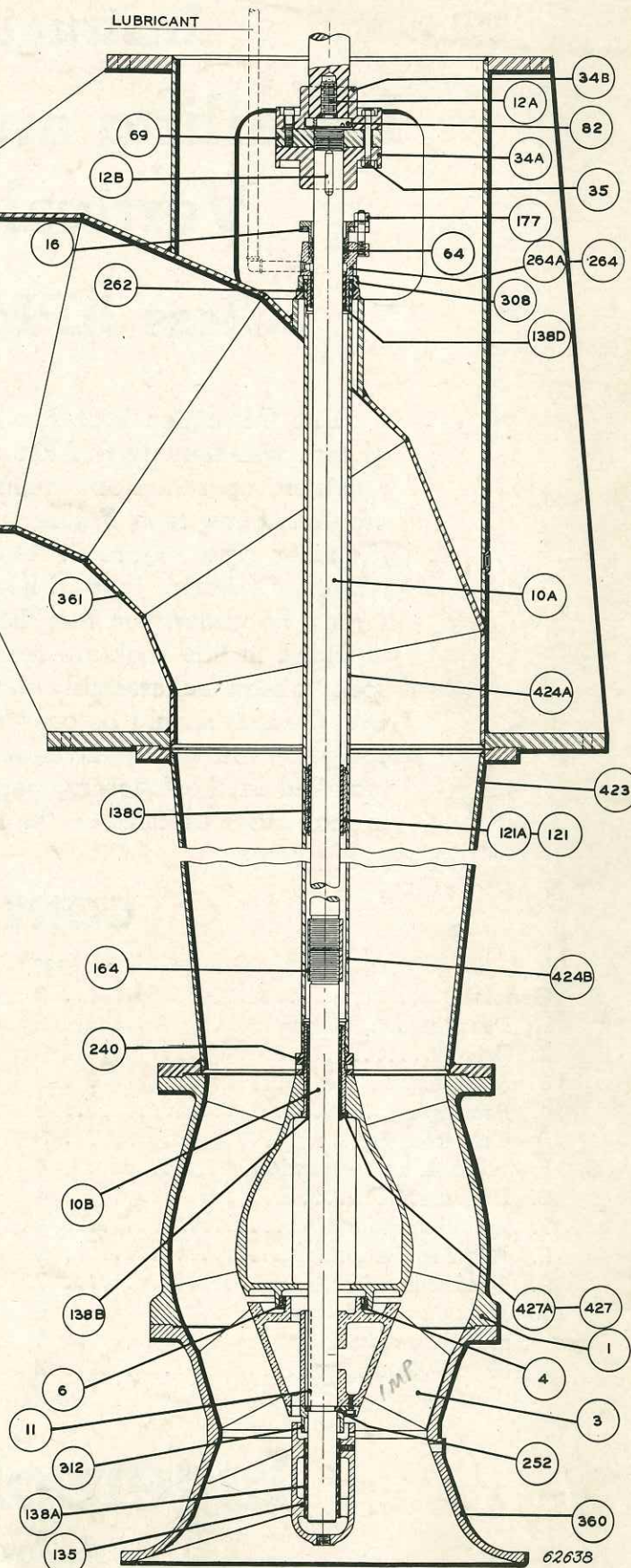


Fig. 1. Class APM, mixed-flow pump.
See Fig. 9 for part names.

4. Bearings

The three types of bearings used for these pumps are oil-, water- or grease-lubricated. Several combinations of these bearings are available.

- Water-lubricated bearings throughout.
- Water-lubricated column bearings with grease-packed lower bearing.
- Oil-lubricated column bearings with grease-packed lower bearing.

Water-lubricated bearings are of the cutless rubber type and are lubricated by circulation of clear fresh water, Fig. 2. Oil-lubricated bearings are lubricated by maintaining the inner column full of oil, with a drop oiler, Fig. 3. Grease-lubricated lower bearings are packed with hydraulic grease before leaving the factory and need be repacked only at three to five year intervals, Fig. 4.

5. Characteristics

Characteristics of these pumps differ from centrifugal pumps in that minimum brake horsepower (b hp) occurs at maximum capacity (and lowest head) and increases as capacity is reduced. Maximum brake

horsepower occurs at no flow against a closed discharge valve.

Most units are furnished with drivers suitable for carrying the load at the design conditions and several methods can be employed to prevent operation at peak horsepower, which is near and at shutoff.

These will be discussed later under "Starting", paragraph 12.

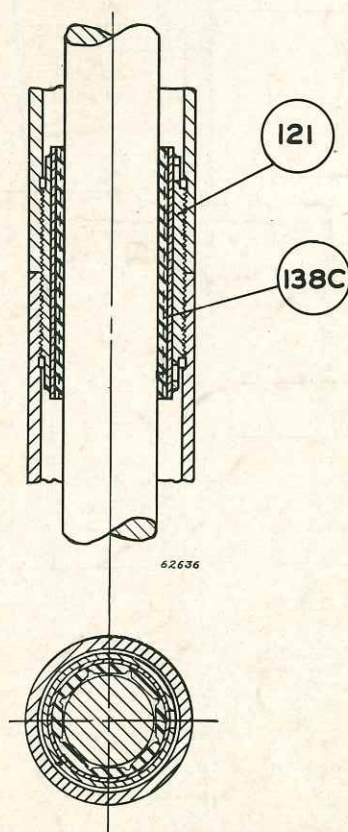


Fig 2. Water-lubricated, cutless-rubber bearing.
Part no. 121—Column-bearing holder.
Part no. 138C—rubber bearing, column

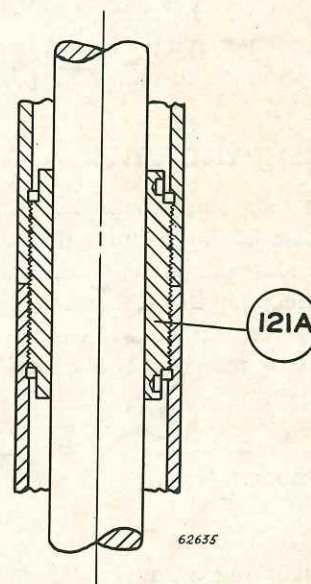


Fig 3. Oil-lubricated bearing.
Part no. 121A—Column bearing, metal

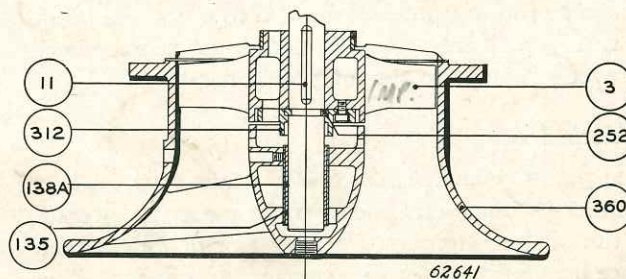


Fig 4. Grease-packed lower bearing.
Part no. 135—lower bearing.

B. INSTALLATION AND OPERATION

6. Location of pump

These pumps are installed in a well or canal so that the lower end of the unit is submerged in the liquid. Sufficient submergence should be provided so that vortices will be suppressed as these allow air to enter the pump suction with resulting reduction in capacity. The velocity in the well or canal should be low to prevent turbulence. For average conditions the minimum distance from sump floor to the bottom of the suction bell, and from side walls to suction bell should be $\frac{1}{2}$ of the suction-bell diameter. The water level should be at least 5 ft above the bottom of the suction bell. For very large pumps or unusual operating conditions greater clearance and submergence may be necessary as recommended by the manufacturer.

Install the unit with sufficient head room and adequate facilities for removing the unit from the pit. Access should be provided to the stuffing box.

7. Installing the unit

Vertical pumps are shipped either as complete units or in the case of large units or long column lengths, they are shipped partially dismantled. In the latter case, the pumping element is shipped assembled as a complete unit, and the inner and outer column, intermediate shafting, and supporting head are boxed separately.

A unit shipped dismantled may be installed by either of two methods.

a. Method 1

Assemble complete unit on a level floor taking care that shafting is not bent or sprung during handling. Each additional section of shaft is coupled to the pump shaft, and is then covered by the inner column which is threaded into position and then covered by corresponding section of outer column. The assembly should be made starting from the pump-element end and working toward the driver.

This method of installation, as well as pumps which are shipped completely assembled, requires suitable crane capacity. If possible, two slings should be used to raise the pump from a horizontal to a vertical position and lower it into the pit. Care must be exercised to prevent damage to the long sections.

b. Method 2

The pump element, with first sections of the outer and inner columns and the shaft in place, is lowered into the pit and supported at the floor or foundation surface by clamps under the outer-column flange. The next sections of shaft, inner and outer column are then added. A clamp is then placed at the top flange and

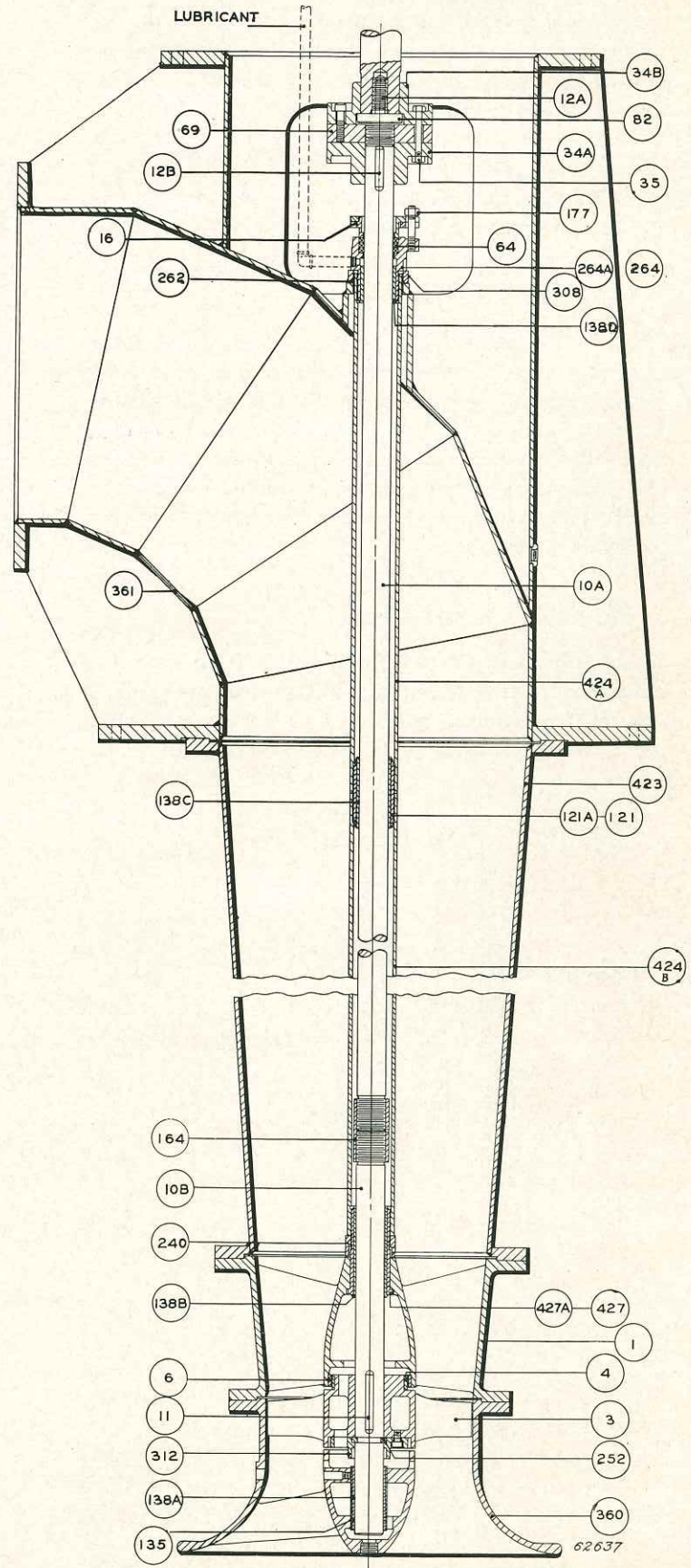


Fig. 5. Class APS, axial-flow pump
See Fig. 9 for part names

B. INSTALLATION AND OPERATION

the whole assembly is suspended on the crane. The bottom clamp is then removed and the unit is lowered one more section into the well. The remaining sections are added in a similar manner until the entire unit is installed.

In either method care should be used in threading the shaft sections together to prevent damage to the smooth surface of the shaft especially where it passes through the bearings. Clamp wrenches should be used for this purpose. We recommend that threaded joints be coated with rust-preventing compound.

8. Aligning unit

After the pump is in position, the unit must be aligned. Level across the supporting-head plate, using shims between the support plate and foundation if necessary. Final setting must be made by checking the coupling alignment.

9. Connecting the piping

Align the discharge piping so that a minimum strain is placed on the pump when the flanges are bolted up.

10. Mounting the driver

a. Hollow-Shaft Units

Lower the hollow-shaft motor down over the pump shaft. Set motor in the counterbored joint in the supporting head; then turn the motor until the bolt holes line up. Then bolt and dowel the motor in place. Remove the cover plate at the top of the motor. **IMPORTANT:** Before placing pump half-coupling on the shaft check the motor rotation. Rotation must coincide with direction arrow on the unit. Reverse motor rotation will cause the shaft coupling to back off and may cause serious damage to the pump.

After motor rotation has been checked, slide the pump half-coupling over the shaft key on to the pump shaft. Insert the coupling bolts and tighten.

b. Solid-Shaft Units

The driver coupling is keyed to the driver shaft and is anchored to prevent axial movement by means of a locking bolt. Be sure this bolt is pulled up tight. Set the driver on the driver support and align the coupling halves and the shaft-adjusting nut so that the outer diameters are in line within .003 inch and the driver coupling half and the face of the shaft-adjusting nut are parallel within .003 inch. **IMPORTANT:** Before inserting any coupling bolts check the driver rotation. This must coincide with the direction arrow on the

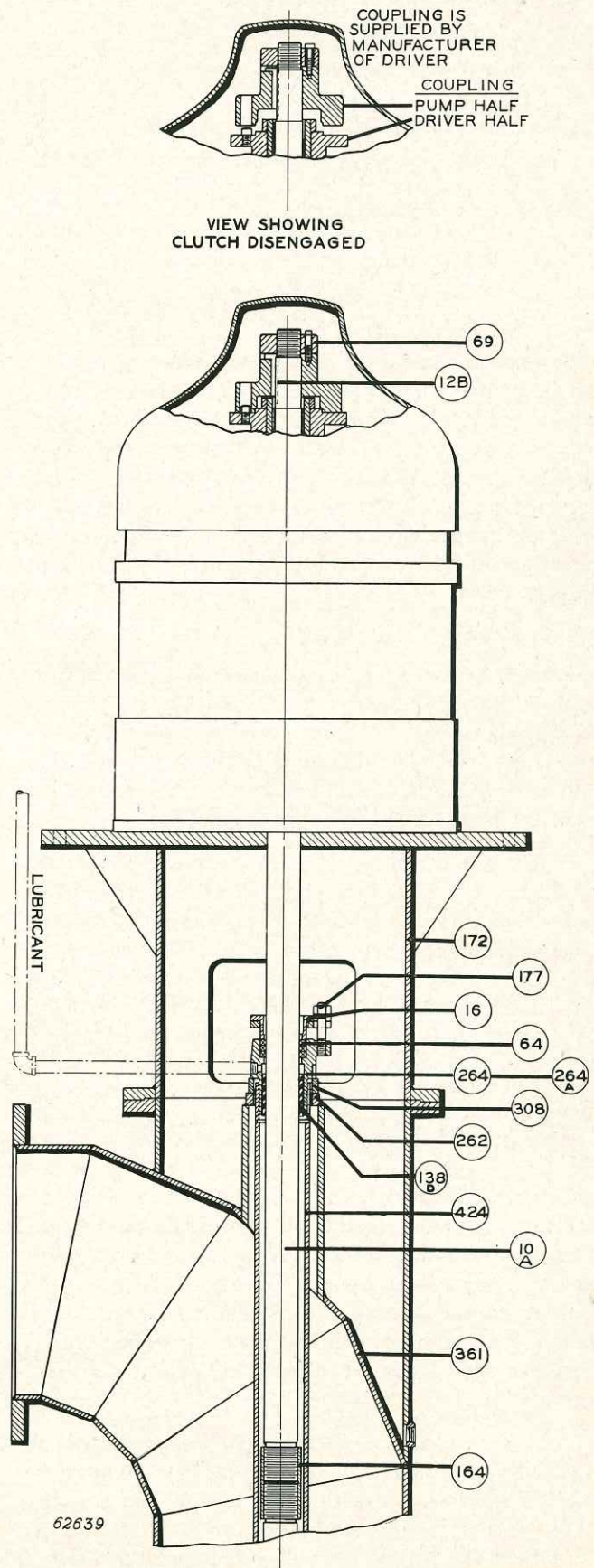


Fig 6. Construction details of pump with hollow shaft motor. See Fig. 9 for part names.

unit. Reverse driver rotation will cause the shaft coupling to back off and may cause serious damage to the unit.

11. Adjusting pump rotor

a. *Hollow-Shaft Units (Fig. 6)*

Before operating the unit the entire rotating element of the pump must be raised to provide clearance between the propeller and the suction head. The shaft-adjusting head has been designed for this purpose and the clearance is set as follows:

Screw the shaft-adjusting head on the upper end of the pump shaft which extends above the pump half-coupling. By drawing up on the shaft-adjusting head, the pump rotating element will be raised. Turn the shaft-adjusting head until the rotor is free to turn. Line up the lock-bolt hole in the shaft-adjusting head with the tapped hole in the pump half-coupling, and insert the lock bolt. Check again to see that the shaft rotates freely.

b. *Solid-Shaft Drives (Fig. 7)*

When the pump is uncoupled the impeller rests against the suction head and will not be free to turn. Before operating the unit the entire rotor must be raised to provide a clearance between the propeller and the suction head. The shaft-adjusting nut of the rigid coupling has been designed for this purpose.

Before the coupling-stud bolts and coupling bolts are inserted, back off the shaft-adjusting nut until its upper face is in contact with driver half-coupling face. Line up the tapped holes in the shaft-adjusting nut with the stud-bolt holes in the driver half-coupling and insert the stud bolts. Draw these bolts up tight. The driver half-coupling and the shaft-adjusting nut are now coupled and will turn as a unit. By turning the driver shaft clockwise, the adjusting nut will raise the pump shaft, as the shaft nut screws down on the threaded end of the pump shaft.

The rotating element should be raised in this manner until the pump rotor will turn without rubbing. Make a final check on the coupling alignment before inserting the coupling bolts. Shim between the driver flange and the pump-supporting flange if necessary. Insert the coupling bolts and draw up tight. Again, check the unit by hand to see if the rotating element is free to turn.

NOTE: On APS units, fig 5, the casing is cylindrical and the propeller blades do not rest against the suction head when the pump is uncoupled. The propeller hub rests against the bottom-bearing housing. To adjust the rotor on this type of unit the shaft is raised with the adjusting nuts, as described above under either hollow- or solid-shaft drivers as the case

may be, until the back of the propeller hub strikes the diffuser casing. The rotor is then lowered half the distance the shaft was raised, which is the correct setting. The rotor should be turned by hand to make sure it is free to turn without rubbing.

12. Starting

The pump must be flooded in the pit before being started. Be sure the bearing lubricant is flowing to the unit. In the case of water-lubricated bearings, always turn on the bearing water supply a few minutes before the pump is started.

Before starting an oil-lubricated unit for the first time pour about a pint of oil into the inner column above the bearings. After the initial starting period, oil is automatically supplied by the drop-oil lubricator as described under oil-lubricated bearings.

Follow the motor manufacturers' instructions for proper starting of the motor.

In most cases there will be no valves in the discharge line, however, in condenser installations with two pumps operating in parallel, each may have a valve in the discharge line. When there are valves in the discharge line they should be opened wide before starting, as this type of pump requires the least horsepower under full-capacity rating. To prevent starting against a closed valve some installations are equipped with by-pass lines. The pump can then be started with a closed discharge valve, as the open by-pass line passes enough water to reduce the horsepower. Always open the by-pass line before closing the discharge valve. In some condenser installations with two pumps piped in parallel, it is sometimes necessary to start the idle pump with pressure on the system being supplied by the operating pump. To start an idle pump under these conditions, the discharge valve should be partially opened before starting. This will cause the idle pump to rotate in reverse direction, due to water flowing from the system back through pump to intake tunnel. However, the unit can be started while operating in reverse rotation since no mechanical, hydraulic or electrical shock is developed during such a starting procedure. The net result will be a slightly longer starting period. As soon as the unit is started, the discharge valve should be opened wide.

IMPORTANT: After the unit has been operating for a short time it should be shut down and the rotor turned by hand to make sure it is free and not rubbing. This is necessary since under load the shaft might stretch enough to cause the propeller to rub on the casing. If the rotor cannot be turned freely by hand, the rotor should be adjusted as described under rotor adjustment. Paragraph 11.

C. CARE AND MAINTENANCE

13. Stuffing boxes and packing

Stuffing boxes are used only to retain the lubricating medium in the inner column and to prevent foreign matter from entering the unit. After the initial adjustment they should require very little attention.

The stuffing-box extension is held in the inner column by a threaded connection. This extension clamps a gasket between the gland ring and an extension on the discharge elbow, forming a seal.

14. Bearings

a. Water-Lubricated (Fig. 2)

Pumps equipped with water-lubricated column bearings should be supplied with clear fresh water introduced through a pipe connection at the stuffing-box extension. Water is forced through the top bearing down through the inner column to the lower bearings. After passing through the bearing at the casing the water flows through cored holes in the impeller and out into the main suction stream.

Constant and positive lubrication must be provided at all times for the rubber bearings. Starting or operating without water lubrication to the bearings will destroy them. Water should be supplied at at least fifteen pounds pressure.

b. Oil-Lubricated (Fig. 3)

When the pump is equipped with oil-lubricated column bearings, a solenoid drop-oil Lubricator is mounted at the floor support. This lubricator is interlocked with the main motor-starting circuit so that the solenoid is energized and the lubricator is put in operation when the driving motor is started.

This lubricator is a solenoid-operated, sight-feed type consisting of a glass reservoir and a sight-feed glass. It can be regulated, for the exact amount of oil required, by a needle stem located directly above the sight-feed glass. The solenoid valve located above the reservoir automatically controls the flow of oil so that oil is fed only when the electric current is on. The solenoid valve consists of a coil which, when it is energized, lifts a plunger off its seat, causing the oil to feed until the circuit is broken. When the circuit is broken the plunger falls by gravity to its seat effecting a positive shut-off of the oil.

The oil from the lubricator is introduced above the top bearing, and flows down through each column bearing.

Oil is ordinarily fed at the rate of three to four drops per minute. However, for the first two weeks of operation, it should be fed at a rate of fifteen drops per minute.

The type of oil used depends on the temperature. A good average is an oil having a viscosity of 150 to 250 SSU at 100°F. Any good grade of turbine oil with the above characteristics should be satisfactory.

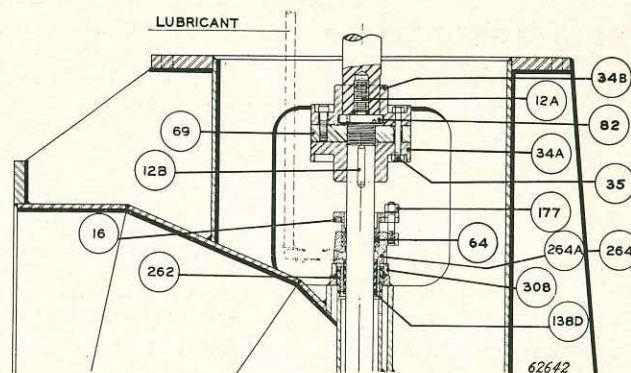


Fig 7. Stuffing box detail and coupling detail of unit with solid-shaft driver. See Fig. 9 for part names.

c. Grease-Packed (Fig. 4)

The lower bearing which is housed in the suction head is packed with grease before shipment and will not need further lubrication during operation. When the pump is dismantled for inspection, this bearing should be packed with a good grade of hydraulic grease.

15. Restoring running clearances

To restore running clearances after the pump has been in operation for some time, adjust the rotor as described in paragraph 11, using the method applying to the type of driver, that is, hollow-or solid-shaft.

16. Dismantling and assembly

To dismantle the pump, first, remove the driver and pull the unit from the pit, placing it on the floor. If the unit is equipped with a coupling, remove the pump half-coupling and the stuffing-box gland. Remove the supporting head and the outer-column sections. This will expose the inner column. Unscrew and remove the inner-column sections, thus exposing the shaft coupling. Unscrew the shaft (lefthand thread) and remove the shaft sections. Remove the casing bushing and unbolt the suction head. This will expose the impeller which can be removed with its shaft.

In cases where the pump cannot be pulled from the pit as a unit, dismantle as above by using clamps as described in Method 2 under heading "Installation", paragraph 7.

Assembly of the pump should be in the reverse order, making sure all the joints are clean. Paint all flange joints with red lead. Repack the lower bearing with the specified grease. Before the driver coupling is reconnected, check alignment and rotor clearance.

On pumps equipped with oil-lubricated column bearings, pour about one pint of oil into the inner column above bearings.

17. Spare parts

Although there is very little wear in this type unit, the following spare parts should be available for repairs.

Quantity of Spare parts	Name part	Part Number	
		Oil lubrication	Water lubrication
1	Lower bearing. .	135	138-A
1	Casing bearing..	427-A	138-B
1	Column bearing.	121-A	138-C
1	Impeller ring....	4	4
1	Casing ring.....	6	6

When ordering parts, please give:

- (1) The NUMBER of the part as listed.
- (2) the NAME of the part as listed.
- (3) the SIZE and TYPE as given on the pump nameplate.
- (4) the SERIAL NUMBER as given on the pump nameplate.
- (5) when possible give the complete SYMBOLS stamped on the old part.

By giving complete information you will enable us to fill your order correctly and avoid unnecessary delays.

Part No.	Name of Part
1	Casing
3	Impeller
4	Impeller ring
6	Casing ring
10A	Shaft—intermediate
10B	Shaft—Impeller end
11	Impeller key
12A	Coupling Key—driver side
12B	Coupling key—pump side
16	Gland—2 halves
34A	Coupling—pump half
34B	Coupling—driver half
35	Coupling bolts and nuts
64	Packing—stuffing box
69	Shaft—adjusting nut
82	Locking screw—coupling
121-138	(See below)
164	Shaft Coupling
172	Supporting head
177	Lock nut—gland
240	Lock nut—casing bushing
252	Split ring—impeller
262	Packing ring—gland ring to column
264	(See below)
308	Gland ring—stuffing box
312	Lock collar—impeller
360	Suction head
361	Discharge head
423	Outer column
424A	Inner column—upper
424B	Inner column—lower
427	(See below)

OIL-LUBRICATED BEARINGS

121A	Column bearing—metal
135	Lower bearing
264A	Stuffing box extension
427A	Casing bearing—metal

WATER-LUBRICATED BEARINGS

121	Column—bearing holder
138A	Rubber bearing—suction head
138B	Rubber bearing—casing
138C	Rubber bearing—column
138D	Rubber bearing—stuffing box
264	Stuffing box extension
427	Casing—bearing holder

Fig. 9. Parts listed on fig 1 to 8.

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Steam-Jet Water-Vapor

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Jackhammers
Jacklegs
Pickhammers
Power-Feed
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Wagon-Mounted

Sharpeners & Furnaces

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Compressors, Rail Mounting
Crawl-Air Compressors
Pneumatic Tie Tampers
Rail and Bond Drills
Spike Drivers and Pullers
Spottamper Compressors
Track Wrenches
Vacuum Pumps
Steam-Jet Ejectors
Reciprocating Dry